22. On the Anatomy of the Drill (*Mandrillus leucophæus*). By CHARLES F. SONNTAG, M.D., F.Z.S., Anatomist to the Society.

(Text-figures 9–24.)

CONTENTS.

The literature of the Primates contains very few references to the structure of the Drill, so an account of its anatomy should be useful. The present description is based on the examination of an adult male which died in the Society's Gardens. It had the following proportions :—

Length from tip of nose to root of tail	29·5	inches.
Tail	3·5	,,
Length of head	9	,,
,, ,, body	20·5	,,
Arm	8	,,
Forearm	8·6	,,
Thigh	9·5	,,
Leg	8·7	,,

MYOLOGY.

The *platysma myoides* is strongly developed in both neck and face, and has a well-marked attachment to the lips. The *muscles of the lips and frontal region* are also very strong and thick ; and it is to their great development that the frequent movements of scalp and exposure of the teeth are due.

The *temporal and masseter muscles* are powerful, and the upper part of the latter is concealed by the parotid gland (text-fig. 9). But the full, rounded muscle is seen beyond the limits of the gland. The former appears as a well-marked prominence above the zygoma as in many of the Carnivora.

The arrangement of the vessels and nerves on the surface of these muscles differs from that in many Primates and Carnivora.

Sterno- and Cleido-mastoid :—Both muscles are powerful, but there is no gap between them at any point. The former arises from the anterior border of the manubrium sterni and margin of the sternal end of the clavicle (text-fig. 10 A, S.M). The latter originates from the inner fourth of the clavicle, and gradually gains the deep surface of the sterno-mastoid. Both muscles are inserted into the mastoid region and occipital crest. There is no separate cleido-occipital. The spinal accessory nerve is deep to both muscles. In some Primates there is no clavicular fascicle.

The *omo-hyoid* is flat, thin, undivided into bellies, and has no central tendon. The hyoid and scapular attachments show nothing peculiar, but there is no fascial connection to the sternum.

The *pretracheal muscles* show nothing peculiar.

Text-figure 9.
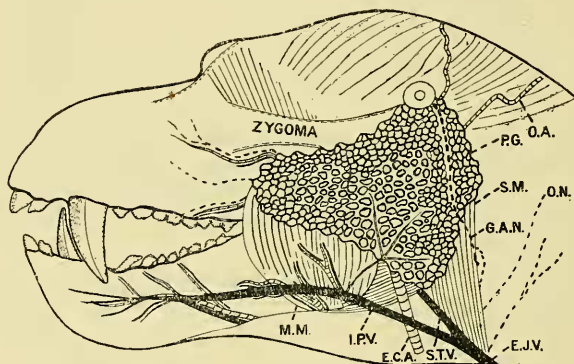
The superficial anatomy of the side of the head, after the skin and platysma have been removed. G.A.N : great auricular nerve ; O.N : occipital nerve ; S.M : sterno-mastoid ; P.G : parotid gland ; O.A : occipital artery ; E.C.A : ectocarotid artery ; I.P.V : inferior labial vein ; S.T.V : superficial temporal vein ; E.J.V : external jugular vein ; M.M : masseter muscle.

The *digastric* belongs to Parson's first type (4), but no fascia unites it to the hyoid bone. And there is no essential difference between it and that in *Macacus rhesus**. The posterior bellies are very strong, and the tendinous arch is long and powerful.

The *stylo-mandibular ligament* is partly ossified, and gives origin to the stylo-hyoid muscle which is tunnelled by the inter-mediate tendon of the digastic. The *stylo-hyoid ligament*, how-ever, is not ossified.

The *mylo-hyoid* is strong and thick, but its attachments show nothing peculiar.

The *hyoglossus* separates the hypoglossal nerve from the

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* C. F. Sonntag, P. Z. S. 1919, p. 437.

lingual artery and branches of glosso-pharyngeal nerve as in Man, and the well-marked submaxillary gland lies on its surface. It is united to its fellow to form one sheet. It is continuous with the sterno-hyoid.

The *pectoralis major* (text-fig. 10 A) is strong and complex, and consists of several parts. The first is strong and thick, and arises from the margin of the sternal end of the clavicle, the entire length of the sternum, the inner ends of the costal carti-lages, and the aponeurosis over the rectus abdominis in the infra-sternal fossa. Its superficial fibres fuse with those of the deltoid.

Text-figure 10.
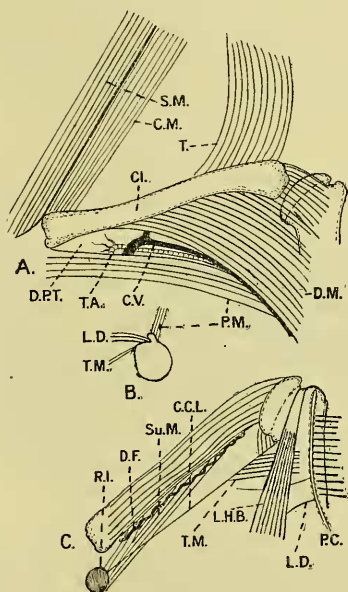
Muscles of the shoulder-girdle. A : superficial aspect; B : the humerus on section across the pectoral crest; C : structures under the pectoralis major and deltoid C.M : cleido-mastoid; P.M : pectoralis major; Su.M : subclavius; T : trapezius; T.A : thoracic axis artery; C.V : cephalic vein; Cl : clavicle; D.F : deep fascia; R.I : first rib; T.M : teres major; L.H.B : long head of biceps; P.C : pectoral crest.

The second part covers the inner part of the chest-wall and part of the external oblique aponeurosis, and joins the deep aspect of the first part which is inserted into the capsule of the shoulder-joint and the prominent pectoral ridge on the humerus. A third part arises from the second, third, fourth, and fifth costal carti-lages and intercostal muscles in the intervening spaces, and is inserted into the capsule of the shoulder-joint and deep part of

the preceding part. It works over a strong cord running from
the first rib to the head of the humerus (text-fig. 10 C. C.C.L).
And this ligament may replace the costo-coracoid ligament in
Man. The first and third parts receive separate nerves from the
median nerve, but the latter probably only serves as a track from
the brachial plexus (text-fig. 23).

The *pectoralis minor* may be replaced by the third part of
pectoralis major.

A long, narrow muscle, composed of two bellies, takes origin
from the free edge of the latissimus dorsi, crosses the axillary
vessels and brachial nerves, and spreads out into a thin fan-
shaped aponeurosis. The latter covers the coraco-brachialis and
biceps, and is inserted into the deep surface of the insertion of
pectoralis major. It has a double nerve supply from the second
intercostal nerve and brachial plexus (text-fig. 11, G).

The *subclavius* (text-fig. 10 C) is very strong. It arises from
the inner end of the first rib by a strong pointed tendon, and is
inserted into the inner five-sixths of the posterior surface of the
clavicle.

The *delto-pectoral triangle* (text-fig. 10 A, D.P.T) is long and
narrow. It contains the cephalic vein and thoracic axis artery,
but no lymphatic glands.

The skin over the pectoral region is supplied, as in Man, by
the supraclavicular nerves from the cervical plexus.

The *trapezius* arises from the inner part of the occipital crest,
the inion, ligamentum nuchæ, seventh cervical and upper six
dorsal spines, and supraspinal ligaments. And the thick, strong
fibres converge, as in Man. They are inserted as in Man, but the
fibres which are attached to the root of the spine of the scapula
end in a very strong triangular tendon, under which the spinal
accessory nerve passes to the posterior part of the muscle. The
sub-trapezial nerve plexus formed by the spinal accessory and
cervical nerves is well-developed.

Latissimus dorsi:—No fibres are derived from ribs and the
posterior angle of the scapula, and the upper fibres of origin are
under cover of the trapezius. They extend from the fourth to
the last dorsal vertebra, behind which they arise from the lumbar
aponeurosis, but no fibres extend back to the ilium. The fibres
converge, wind round the lower border of the teres major, and end
in a very strong, flat tendon which is inserted into the humerus
at the base of the pectoral crest (text-figs. 10, L.D and 11, H).
The tendon is intimately connected to the teres major and dorso-
epitrochlearis.

The *levator anguli scapulæ* arises from the dorsal surfaces of
the transverse processes of the first four cervical vertebræ, and
the slip from the first one is the largest. The fibres unite to
form a thick muscle, which is inserted into the vertebral border
and deep surface of the scapula in its anterior part.

The *rhomboids* form a strong muscular sheet arising from the
vertebral spines from the seventh cervical to the fifth dorsal:

and it is inserted into the vertebral border and margin of the deep surface of the scapula. It is impossible to separate it into major and minor rhomboids. The sheet does not extend to the occiput as it does in many Primates.

The *serratus magnus* arises from the first ten ribs and inter-spaces, but the origin forms a uniform muscular line instead of pointed slips as in Man. Its insertion into the vertebral border of the scapula is thick and muscular.

The *omo-trachelian* is a powerful muscle attached to the supra-spinous fossa and root of the spine of the scapula.

The *dorso-epitrochlearis* (text-fig. 11, J) is a very strong muscle. It is $4\frac{1}{2}$ inches long and $1\frac{1}{2}$ broad. Proximally it is intimately connected to the latissimus dorsi and teres major. Its rounded distal border is bound by a strong tendon to the internal condyle of the humerus and the olecranon. It is supplied by a branch of the musculo-spiral nerve (text-fig. 23, D.E.M).

Text-figure 11.
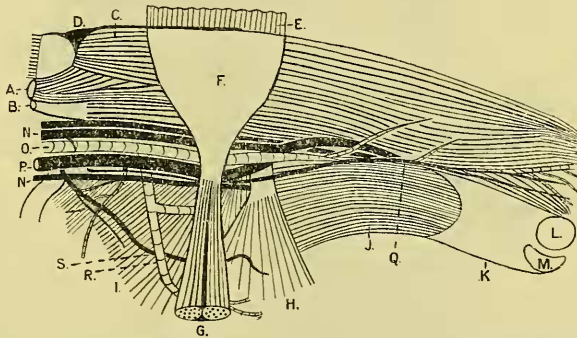
The structures in the axilla and arm. A and C: short and long heads of biceps; B: coraco-brachialis; D: fascia; E: pectoralis major; F.G: axelbogen; J.K: dorso-epitrochlearis; L: internal condyle; M: olecranon; N.O.P: axillary vessels and nerves; R.S: long subscapular artery and nerve. Other letters in text.

The *deltoid* (text-fig. 10, D.M) is very powerful, and its super-ficial fibres are fused with those of the pectoralis major. It has an extensive origin from the whole of the ventral surface of the clavicle except the sternal end, the acromion, and outer two-thirds of the spine of the scapula. And the fibres arising from the acromion are tendinous. All converge to the usual deltoid insertion.

The *teres major* (text-fig. 11, I) has the same origin and insertion as in Man, but it is intimately blended with the latissimus dorsi and dorso-epitrochlearis. The *teres minor* has also an origin similar to that in Man, but its tendon of insertion is pushed on to the humerus distal to the greater tuberosity.

The *subscapularis* arises from the entire subscapular fossa, and has a great admixture of strong tendinous fibres. The latter converge and pass over the lesser tuberosity to be inserted into its upper border. The tuberosity with these tendons presents a full, rounded appearance.

The *supraspinatus* arises from the outer two-thirds of the supra-spinous fossa and is inserted into the upper part of the great tuberosity of the humerus. The *infraspinatus* arises from the outer two-thirds of the infraspinous fossa. It is inserted by two heads into the great tuberosity of the humerus and the bone beyond it, so as to displace the insertion of the teres minor distally (text-fig. 12 C).

The *biceps* arises by two heads as in Man, the short one joining the long one in the upper third of the arm. The muscle converges to a long, flat tendon which is inserted into the dorsal

Text-figure 12.
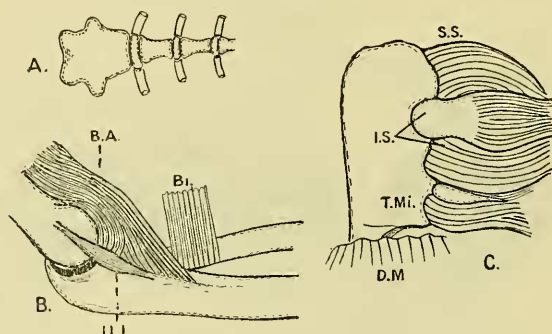
A : manubrium sterni of Drill and Mandrill*. B : flexors of elbow-joint ; C : muscles attached to the great tuberosity of the humerus. B.A : brachialis anticus ; Bi : biceps ; D.M : deltoid ; I.S : infraspinatus ; S.S : supraspinatus ; T.Mi : teres minor ; I.L.L : internal lateral ligament.

aspect of the proximal part of the radius from the head to the point where the bone begins to exhibit its marked forward convexity (text-fig. 12 B). It first narrows slightly and expands later. There is no bicipital fascia as in Man.

The *coraco-brachialis* has a long, powerful tendon of origin and an elongated fleshy belly inserted into the shaft of the humerus close to the deltoid insertion.

The *brachialis anticus* arises as in Man. It has a very strong tendon which winds round the internal condyle of the humerus, and is inserted into the upper inch of the inner surface of the shaft of the ulna, and the internal lateral ligament of the elbow joint (text-fig. 12 B).

The *triceps* is a very powerful muscle. Its long head arises

* Vrolik states that the manubrium is absent in the Mandrill.

from the lateral two-thirds of the axillary border of the scapula, and some fibres fuse with the proximal part of the dorso-epitro-chlearis. The two humeral heads have extensive areas of origin. The strong tendon of insertion passes to the dorsal aspect of the extremity of the olecranon, but some fibres pass along the side of the tendon to be attached to the proximal inch of the lateral border of the ulna.

As the hands were not at my disposal, no attempt was made to dissect out the muscles of the forearm.

The *sartorius* arises from a narrow area on the ventral border of the ilium ; and its origin bounds an arch through which the

Text-figure 13.
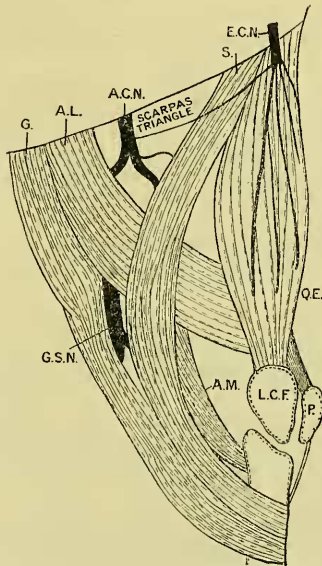
Muscles of the thigh. A.M : adductor magnus; A.L: adductor longus ; G : gracilis ; S : sartorius ; Q.E : quadriceps extensor attached to internal femoral condyle (L.C.F.) and patella (P.) ; A.C.N., E.C.N., G.S.N : anterior crural, external cutaneous and great sciatic nerves.

lateral cutaneous nerve of the thigh emerges. It is inserted into the front of the shaft of the tibia distal to the insertion of the quadriceps extensor. To reach that point it describes a curve like the italic *f*. It helps to bound three triangles—a deep Scarpa's Triangle whose boundaries are as in Man, a triangle whose other boundaries are the adductor longus and gracilis, and a triangle whose other boundaries are the quadriceps tendon and internal femoral condyle. In the latter triangle the tendon of the adductor magnus is seen passing the internal condyle to reach the tibia (text-fig. 13).

The *gracilis* (text-fig. 13) fuses with sartorius at its insertion, and the combined muscles are inserted along one-third of the length of the ventral border of the tibia.

The *adductor longus* (text-fig. 13) has a long attachment to the femur, and its distal limit is about half an inch above the internal condyle.

The *adductor magnus* (text-fig. 13) is a long, narrow muscle whose tendon is attached to the upper end of the tibia.

The *great sciatic nerve* divides at the bottom of the triangle formed on the inner aspect of the thigh by the sartorius, gracilis, and adductor longus.

The *anterior crural nerve* divides into two main branches in Scarpa's Triangle.

The *external cutaneous nerve* breaks up into a number of branches over the quadriceps, and communicates with the anterior crural nerve.

The *quadriceps extensor* is inserted into both condyles of the femur and upper border of the patella, and the ligamentum patellæ is attached to the tibia over a length of two inches. At the lower limit of the latter is the long strip of attachment of the sartorius and gracilis. The vastus internus component is extremely powerful.

The *glutei* have coarse, thick fibres, but they are not voluminous as in Man. The gluteus medius is much thicker than the maximus.

The *levator ani* is a very stong, thick muscle, but the *pyriformis* is very long, thin, and slender. It cannot be employed in subdividing the structures passing from the pelvis to the thigh as in Man.

The *great sciatic nerve* gives off a very thick cord to the hamstrings after it winds beyond the femoral trochanter. These muscles are inserted into the upper half of the dorso-lateral border of the tibia.

The gluteus minimus and lateral rotators of the thigh form a thick fan-shaped muscle, with many tendinous fibres originating along the entire vertical length of the ilium.

The Alimentary Canal.

Fleshy *lips* are connected to the gums by well-marked frenums, but no labial tubercles are present.

The *oral vestibule* is smooth and has well-developed cheek-pouches.

The *hard palate* is crossed by twelve pairs of incomplete ridges radiating from the mid-line, but there is no prominent median raphé, and no incisive pad; the ridges become more curved on the posterior part of the palate, and those of the last two pairs are sinuous.

The *soft palate* has a well-marked uvula.

The *tonsils* are two round bodies, the size of large peas, situated in the fauces, and the mucous membrane over them is fenestrated.

The *œsophagus* does not project from behind the trachea in the neck, and it is very capacious in the posterior part of the thorax. Its intra-abdominal part is short. The mucosa is smooth throughout. Many branches of the vagi ramify over its surface just before it passes through the diaphragm.

The *stomach* (text-fig. 14 A), which was empty in this specimen, has no well-marked fundus, but the posterior part of the body was directed posteriorly and to the left. The pyloric region is not firmer than the rest of the stomach, is directed forwards

Text-figure 14.
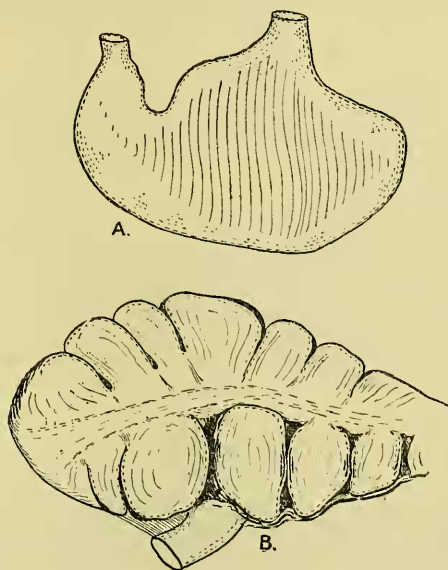
The stomach (A.) and cæcum (B.).

(craniad) and slightly to the right, and is marked off from the duodenum by a constriction. Vrolik (**3**) describes a globular stomach in the Mandrill.

When the stomach is opened along the greater curvature it is seen how there are no rugæ, and no marked pyloric sphincter.

The *duodenum* makes a sharp bend and runs caudad. There is no well-defined loop, and it passes insensibly into the beginning of the jejunum. Valvulæ conniventes are absent, and there is no bile papilla, but merely an orifice.

The entire small intestine is 82 inches long, and the large intestine measures 60 inches without the cæcum.

The *cæcum* (text-fig. 14 B), 3 inches long. is wide and capacious, and is sacculated by longitudinal bands on its dorsal and ventral surfaces. It has a well-marked mesentery, but no artery occupies its free edge. There is no appendix vermiformis.

The *ileo-cæcal orifice* is guarded by a circular valve.

Peyer's Patches are absent entirely. I also found no trace of them in *Papio anubis*.

There is nothing peculiar to note about the peritoneum. The mesenteric vessels run straight to the gut, and do not form tiers of arterial arcades. Reaching the bowel they bifurcate, and the halves unite with those of the neighbouring vessels. Several small lymphatic glands are situated along the vessels at the point where they reach the gut.

The entire mesentery and great omentum are devoid of fat.

The Salivary Glands.

The *parotid gland* (text-figs. 9 & 17) consists of a large triangular superficial part, with small closely-packed lobules, and a deeper part, with larger lobules. In the latter there are many large vessels and nerves.

The *sublingual glands* are the size of hazel nuts. They are closely applied to the inner border of the mandible, and the branches of the lingual nerves disappear under cover of them.

The *submaxillary glands* are large, circular, and flat, and have a large blood supply from the external carotid arteries. They lie immediately posterior to the fused anterior bellies of the digastric muscles. They are, however, relatively smaller in proportion to the size of the animal than those in many other Cercopithecidæ.

The Pancreas.

One of the most notable features in the anatomy of the Drill is the small size of the pancreas. It is almost black in colour, and its component lobules are just visible to the naked eye. It has a thin tail and an expanded body, but there are no lateral or accessory parts. The total length is three and a quarter inches, and the thickness is two millimetres. The head is one inch wide, and the tail is a quarter of an inch across. The duct unites with the common bile-duct.

Many arteries run into it from the splenic artery.

The Liver (text-fig. 15 A).

The liver is square in shape, as in *Papio anubis* (2), but it is thin throughout. The gall-bladder is pyriform, contained in a well-marked fossa, and continued into a long, slender bile-duct which unites with other hepatic ducts to form a long common bile-duct. The latter unites with the pancreatic duct, but there is no bile papilla in the duodenum. The lobes of the liver differ

from those in the Baboons. The left lateral lobe is smaller; the left central lobe is not so wide, and its free margin is notched. The right central lobe is intimately united to the left central lobe, and its free edge is more rounded. The right lateral lobe, caudate and Spigelian lobes are larger relatively to the others than in the Baboons.

Text-figure 15.
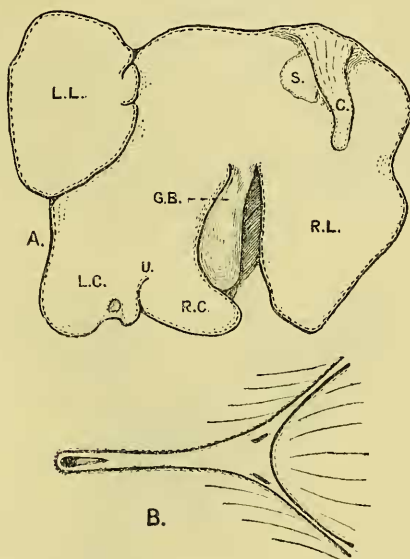
The liver (A.) and trigone of the urinary bladder (B.). G.B : gall-bladder ; U : umbilical notch ; left lateral (L.L.), left central (L.C.), right lateral (R.L.), right central (R.C.), caudate (C.), and Spigelian (S.) lobes.

The lateral fissures are deep, the fissure of the ductus venosus is marked, and the umbilical fissure is bridged over. The vena caval fissure is not bridged over, and the vein is superficial.

The Ductless Glands.

The *spleen* (text-fig. 17 B) is flat and triangular, with rounded angles. The hilum is not linear, as in many Mammalia, but occupies an oval area into which tortuous vessels and sympathetic nerves enter.

The *suprarenal capsules* are small, thin, flat, and helmet-shaped, and lie in the usual positions. Each receives two small arteries from the abdominal aorta and one from the renal artery. The sympathetic plexuses, especially those to the left gland, are very rich and closely related to other abdominal plexuses.

The oval lateral *thyroid lobes* are unconnected, and lie against

the sides of the posterior part of the larynx and first four tracheal rings. They receive an artery from the common carotid, but none from the subclavian as in Man.

The *thymus* was atrophied.

The Urogenital Organs (text-figs. 15 B & 16).

The *kidneys* are small, measuring only $2 \times 1 \cdot 1 \times \cdot 5$ inches. Each has two papillæ, and neither has any fat in its pelvis. The left one is fixed, but the right one, supported by its vessels and ureter, is freely movable among the intestines.

The *bladder* is capacious. On the inner surface is a thickened T-shaped band containing slit-like ureteric and circular urethral orifices (text-fig. 15 B).

The *testes* have large epididymes, and the tunica vaginalis is well-marked. When the parts are relaxed it is seen that

Text-figure 16.
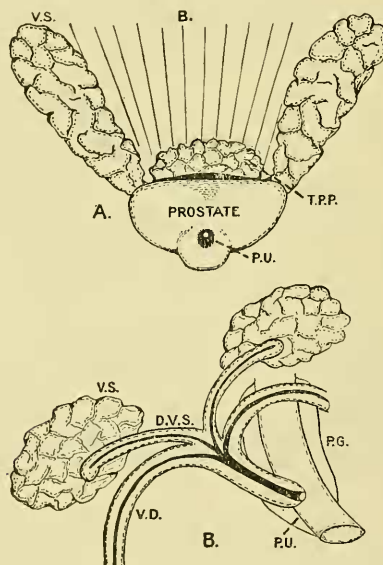
The generative organs. A : general view ; B : bladder ; P.U : prostatic urethra. B : magnified view of the ducts. Other letters in text.

a considerable length of thick spermatic cord extends from the epididymis to the external abdominal ring, which is triangular.

The *vasa-deferentia* (V.D) become confluent, and unite with the ducts of the vesiculæ seminales (D.V.S) to open on a single large papilla in the dorsal wall of the prostatic urethra. No definite vesicula prostatica was seen.

The *prostate* (P.G) consists of a firm pyramidal part enclosed in a capsule, and a triangular part which is softer and lobulated (T.P.P).

The *vesiculæ seminales* (V.S) are two immense masses of lobules bound together by connective tissue and ductules. Many nerves run into them. Their ducts are long, and fuse with the vasa deferentia.

The *corpora cavernosa penis* have large expanded bases.

The Organs of Circulation.

The *heart* (text-fig. 17 A) is 3·5 inches long, 2·5 inches wide, and 2 inches thick. Its *apex* is less pointed than in some Primates, and is composed entirely of the thin-walled right ventricle. The thick-walled left ventricle falls short of the apex by half an inch. The *right auricular appendix* is pointed, and separated from the aorta by a distinct interval. It is slightly

Text-figure 17.
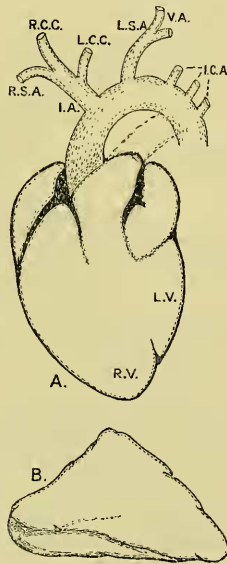
The heart and aorta (A.), and spleen (B.). L.V. and R.V : left and right ventricles. Other letters in text.

notched as in some Marsupials. There are only a few small columnæ carneæ arranged along the inner sides of its walls. The *right auricle* has few columnæ. Between the orifice of the vena cava inferior, which is not guarded by a valve, and the tricuspid valve is a wide coronary opening. The *right ventricle* is capacious and five papillary bundles give the chordæ tendineæ to the

tricuspid valve. Several small muscle bundles connect the
ventricular walls. To the left of the valvular muscles lies the
wide, capacious antrum of the pulmonary artery which has no
columnæ carneæ. The *left auricular appendix* has subdivided
edges, and no columnæ carneæ. The *left ventricle* is thick-walled,
and its small cavity is greatly subdivided close to its apex by
innumerable small muscular bundles.

The *aortic arch* gives off the innominate (I.A) and left sub-
clavian (L.S.A) arteries and upper three left intercostals, and the
former, after giving off the left common carotid artery (L.C.A),
divides into the right subclavian (R.S.A) and right common
carotid (R.C.A) arteries. This arrangement resembles that in
many Primates, Carnivora, and Marsupialia.

The *common carotid arteries* (text-fig. 18) divide at the level of
the upper border of the thyroid cartilage into external carotid

Text-figure 18.
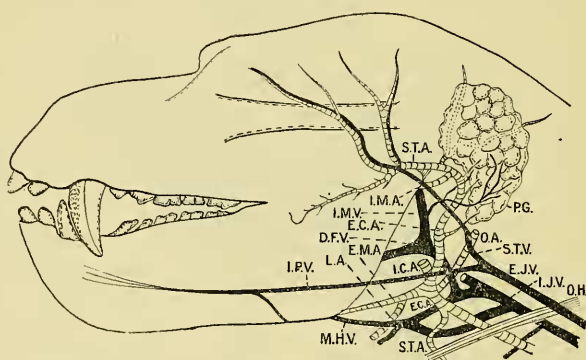
The vessels of the head and neck.   O.H : omo-hyoid muscle
Other letters in text.

(E.C.A), internal carotid (I.C.A), occipital (O.A) and superior
thyroid (S.T.A) arteries, and a sympathetic nerve plexus accom-
panies the branches. Of these, only the external carotid requires
special mention.

The *external carotid artery* (E.C.A) gives off a trunk which
divides into lingual (L.A) and external maxillary (E.M.A)
arteries, and is continued as a trunk which divides into super-
ficial temporal (S.T.A) and internal maxillary (I.M.A) arteries.
The external maxillary is distributed to the lower lip, parotid,
and masseteric regions, and the superficial temporal replaces the
part which, in most mammals, extends to the inner canthus of
the eye. The lingual artery gives off a well-marked branch to
the frenal lamella (text-fig. 19, L.B).

The *subclavian arteries* have the usual course and relations,
and it is noteworthy that the Annulus of Vieussens surrounds

them and their prominent vertebral branches. In most mammals the Annulus, when present, surrounds only the subclavians.

Intercostal arteries:—The upper two spaces on each side are supplied by the superior intercostal branch of the subclavian artery, and the internal mammary artery. The third, fourth, fifth, and sixth left spaces are supplied by the intercostal arteries from the aortic arch and the internal mammary artery. The lower six left spaces are supplied by intercostal branches of the descending aorta and the musculo-phrenic arteries. The right spaces from the third to the twelfth are supplied by intercostal branches of the descending aorta, internal mammary and musculo-phrenic arteries. The internal mammary artery gives off a large branch along the anterior rib, and a thin one along the posterior rib bounding each space supplied by it.

The aortic intercostal arteries are arranged as in those Primates possessing thirteen pairs of ribs.

The *abdominal aorta* gives off branches in the following order:—Inferior phrenics, cœliac axis, splenics, superior mesenterics, renals, spermatics, inferior mesenteric. At intervals it gives off four pairs of lumbar arteries. The first left lumbar artery passes postero-laterally as an ilio-lumbar artery. The aorta ends by dividing into two common iliac arteries, and does not give off a middle sacral (caudal) artery. Lateral sacral branches of the hypogastrics form the caudal artery which passes through chevron bones.

The Veins.

The *inferior labial veins* (text-fig. 18, I.P.V) unite to form a long superficial trunk which opens into the *superficial temporal vein* (S.T.V); and the latter drains the frontal, temporal and orbital regions, and the upper lip. The inferior labial vein communicates with the *mylo-hyoid reins* which drain the muscles and the tongue. The mylo-hyoid trunk (M.H.V) divides into two. One part enters the internal jugular vein (I.J.V), and the other unites with a vessel formed by the internal maxillary (I.M.V) and deep facial (D.F.V) veins. And the resulting vessel opens into the internal jugular vein. The arrangements and relations of these veins are shown in text-figs.

The *external jugular vein* (E.J.V) is formed on the surface of the sterno-mastoid muscle by the union of superficial temporal and inferior labial veins. It has the usual course through the neck, and unites with the subclavian vein to form the innominate vein. The *internal jugular vein* (I.J.V) drains the thyroid gland, and opens into the innominate vein.

The *left innominate vein* crosses the anterior part of the thorax obliquely and unites with the more vertical right innominate vein to form the superior vena cava. The latter receives the vena azygos major in the usual way and ends in the anterior part of the right auricular appendix.

The intrathoracic part of the inferior vena cava is short.

The Organs of Respiration.

Larynx.—The epiglottis is quadrangular, with rounded angles, and is attached to the tongue by a prominent glosso-epiglottic fold. At its base, just above the false cords, a transverse slit leads into a cavity formed by the excavated hyoid bone. From the right side of the cavity a laryngeal sac protrudes. The false cords are thick, the true ones are thin, and the ventricles are deep. The arytenoids are prominent. The upper border of the thyroid cartilage has two small elevations for articulation with the hyoid.

The *trachea* has twenty-four rings which are all incomplete behind.

Lungs.—The left lung has two lobes, and the right one has four, of which one is the azygos appendage.

The Nervous System.

The *Glosso-pharyngeal Nerve* (text fig. 19, IX) has the usual relations to other nerves at the base of the skull, and it communicates with the vagus, hypoglossal, and sympathetic. It winds round the stylo-hyoid ligament, runs antero-mesially, and breaks up into lingual nerves which disappear under the hyoglossus. It sends branches to the pharyngeal and carotid plexuses (P.P and C.A.P), the tonsil, and soft palate.

Text-figure 19.
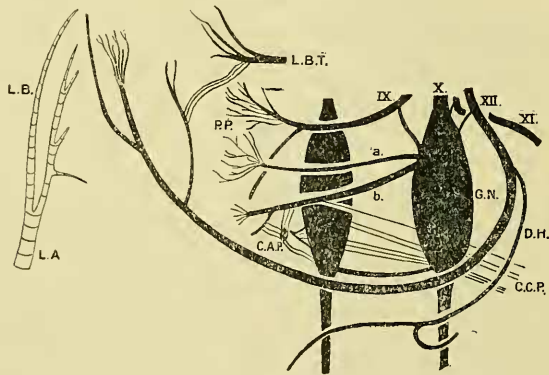
The nerves in the anterior part of the neck. L.B.T : lingual branch of the trigeminal ; L.A : lingual artery. Other letters in text.

The *Vagus Nerve* (text-figs. 19–21) is separate from the sympathetic in the neck. And its course in the neck and thorax is similar to that already described in my papers on the Marsupialia. The ganglion nodosum (text-fig. 19, G.N) is well marked on each side and the following branches are given off:—

1. *Communicating* to the glosso-pharyngeal, accessory, hypo-glossal, and sympathetic.

2. *Pharyngeal nerve* (*a*) which breaks up into the pharyngeal plexus in which it meets branches of the glosso-pharyngeal and sympathetic.

3. *Superior laryngeal nerve* (*b*) which gives off one external branch and a brushwork of internal fibres, and the latter pierce the thyro-hyoid membrane. No external branch connects it to the recurrent nerve, and no depressor nerve arises from it. Communications unite it to the ganglion nodosum and carotid plexus.

No cardiac nerves are given off in the neck.

Text-figure 20.
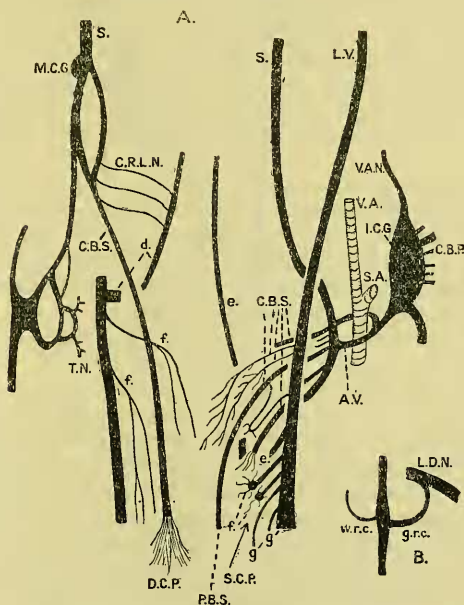
Lower cervical and upper thoracic parts of the vagus and sympathetic. D.C.P. and S.C.P : deep and superficial cardiac plexuses; S.A. and V.A : subclavian and vertebral arteries. Other letters in text.

4. The *right recurrent nerve* (text-fig. 20, *d*) has the usual origin, course, and relations. It communicates with the sympathetic (S), but no branch connects it to the *left recurrent nerve* (*e*). The latter has the usual course, but it does not communicate with the cardiac branches of the left vagus.

5. *Cardiac Nerves* (*f*) :—The left vagus gives off two large branches to the superficial cardiac plexus, and these end in small ganglia which also receive sympathetic filaments. The right

vagus gives off two thinner branches which break up into several twigs to a deep cardiac plexus.

6. *Pulmonary Nerves* (text-figs. 20 & 21, *g* and *g'*) :—The left vagus gives off two anterior pulmonary nerves before it passes to the dorsal surface of the root of the left lung (*g'*). On the dorsal surface of the pulmonary root it gives off three posterior pulmonary nerves (*g*). The right vagus gives off one anterior pulmonary nerve under cover of the vena azygos major, where it curls over the root of the right lung to join the superior vena cava. Behind the pulmonary root it divides into two branches. One of these (*h*) is distributed to the posterior pulmonary plexus, and then rejoins the other division.

7. *Œsophageal nerves* (text-fig. 21, O.N) :—The left vagus gives off several œsophageal branches which form a plexus gulæ. The right vagus gives an ascending œsophageal nerve (O.N') and some small branches which anastomose with those of the left nerve.

The left vagus runs through the ventral part of the œsophageal opening in the diaphragm, and the right vagus runs through the dorsal part. A complicated series of anastomoses between their branches takes place in the posterior part of the thorax (text-fig. 20).

The left vagus gives many branches to the œsophagus and ventral surface of the stomach, and twigs can be traced into the splenic and superior mesenteric plexuses. Communications can also be traced to the left splanchnic nerves (text-fig. 22).

The right vagus supplies the dorsal surface of the stomach, and branches run to the solar plexus (text-fig. 21).

No direct communications run between the vagus and phrenic nerves.

The *Spinal Accessory Nerve* (text-fig. 19, XI) has the usual relations to other nerves at its emergence from the foramen lacerum posticum. It lies on the dorsal aspect of the sterno-mastoid and cleido-mastoid, and it gains the deep surface of the trapezius. It passes postero-laterally and runs over the dorsum of the scapula between the ventral border and root of the spine. It can be traced into the most posterior fibres of the trapezius.

It forms a rich plexus with the cervical nerves, and communications run between it and the ninth, tenth, and twelfth nerves.

The *Hypoglossal Nerve* (text-fig. 19, XII) communicates with the other nerves at the base of the skull and describes a wide loop. Reaching the tongue by passing on the surface of hyoglossus it divides into two branches. One is more superficial, and gives off numerous fine muscular twigs. The other is deeper and thicker, and can be traced almost to the tip of the tongue. Before it divides, the hypoglossal gives off the descendens (D.H) nerve and communicates with the lingual nerve. The former enters as usual into the ansa hypoglossi.

In text-fig. 19 the three distinct nerve supplies to the tongue are shown.

The Sympathetic Nervous System.

Both superior cervical ganglia (text-fig. 19, S.C.G) are present and communicate with the glosso-pharyngeal, vagus, hypoglossal and superior laryngeal nerves (*b*), and the cervical plexus (C.C.P). Branches run to the pharyngeal (P.P) and carotid (C.A.P) plexuses.

Text-figure 21.
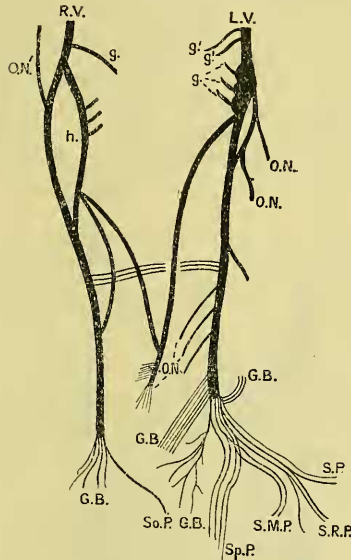
Posterior thoracic and abdominal parts of the vagus nerves. G.B : gastric branches; S.P. and So.P : branches to solar plexus; Sp.P : to splenic plexus; S.M.P : to superior mesenteric plexus; S.R.P : to left suprarenal plexus.

The middle cervical ganglion (text-fig. 20, M.C.G) is only present on the right side, and the Annulus of Vieussens (A.V) is interposed between the sympathetics at the root of the neck and the inferior cervical ganglia (I.C.G). The Annulus on each side encircles the subclavian (S.A) and vertebral (V.A) arteries.

No fusion occurs between the vagus and sympathetic in the neck, and the communications between them take place at the extremities of the cervical course. The left sympathetic gives off cardiac nerves (C.B.S) at the root of the neck, and the right one gives off a cardiac cord from its middle ganglion (C.B.S'), tracheal nerves (T.N), and communicating to the right recurrent laryngeal nerve (C.R.L.N).

The inferior cervical ganglia give off ascending branches which accompany the vertebral arteries (V.A.N) and transverse twigs which run to the brachial plexus (C.B.P). The main sympathetic cords emerge from their posterior parts (T.C.S).

30*

The thoracic cords have fewer ganglia than the numbers of intercostal nerves, and the rami communicantes are of considerable length. In text-fig. 20 B are shown the slender white ramus communicans (*w.r.c*) emerging from the vertebral foramen, and the thicker grey ramus (*g.r.c*) twining round the psoas muscle to join the last dorsal nerve (L.D.N).

The left abdominal sympathetic has five ganglia (text-fig. 22, I–V). It gives off four splanchnic nerves (S.N) which unite to form a loop whence several plexuses radiate. And the loop receives fibres from the left vagus (L.V). Farther back three branches run together to form a long narrow cord, and branches run thence to form the inferior mesenteric plexus (I.M.P). Branches from the right sympathetic join the latter.

The right sympathetic (R.S) divides into the right abdominal cord which has four ganglia (I–IV), and the splanchnic which gives off the phrenic plexus (P.P) and ends in the right renal plexus (R.R.P).

The main sympathetic cords diminish rapidly in size when they enter the pelvis. And each has one ganglion between the pelvic inlet and the point where the two run together at their posterior extremities. No communicating rami were seen running to the sacral plexuses.

Cervical Branches of the Sympathetic (text-figs. 19 & 20).

The anterior ends of the sympathetics give communicating branches to the glosso-pharyngeal, vagus, hypoglossal, and internal laryngeal nerves (*b*). Grey rami communicantes run to the upper cervical nerves (C.C.P). Branches go to the pharyngeal (P.P) and carotid (C.A.P) plexuses.

The right sympathetic gives communications to the right recurrent nerve (*d*), and the tracheal plexus (T.P).

Both sympathetics give off *cardiac nerves* (C.B.S) in the neck, but none arise in the thorax. These meet with branches of the vagus nerves in the superficial and deep cardiac plexuses.

The *Superficial Cardiac Plexus* (text-fig. 20, S.C.P) is composed of :—

1. Two thoracic cardiac branches of the left vagus.
2. Three fine cervical cardiac branches of the left sympathetic.

The *Deep Cardiac Plexus* (D.C.P) contains :—

1. A cervical cardiac branch of the left sympathetic.
2. A large cervical cardiac branch of the right sympathetic.
3. Two thoracic cardiac branches of the right vagus.

The *Thoracic Branches of the Sympathetic* (text-figs. 20 & 22) consist of :—

1. Pulmonary nerves entering the anterior and posterior pulmonary plexuses (P.B.S). They do not arise as separate nerves, but are given off from the cardiac nerves.
2. *Splanchnic nerves* (text-fig. 22) which end in the solar plexus on the left side, and the right renal plexus (R.R.P) on the right.

There is only one splanchnic nerve on the right side, but four form a loop on the left. The connections which they establish through the solar plexus, and by direct branches to the organs, are numerous and complicated, but careful dissection enables one to see the following offshoots :—

a. Superior mesenteric plexus (S.M.P).
b. Splenic plexus (S.P).
c. Left renal and suprarenal plexuses (L.R.P).
d. Right renal plexus (R.R.P).
e. Aortic plexus (A.P).
f. Inferior mesenteric plexus (I.M.P).

Text-figure 22.
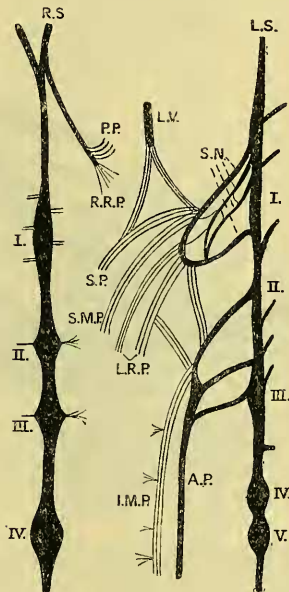
The thoracic and abdominal sympathetic. L.S. and R.S: left and right sympathetic cords ; L.V : left vagus. Other letters in text.

The *Inferior Mesenteric Plexus* sends branches to the large intestine, and a strong cord runs down into the pelvis. Gaining the dorsal aspect of the vesiculæ seminales it forms a crescentic expansion, whence branches run to the left sacral plexus and pelvic viscera.

The *Brachial Plexus* (text-fig. 23) is formed by the fourth to eighth cervical nerves, and branches of communication run to the cervical plexus and first dorsal nerve (C.C.P and C.D.I). In *Macacus rhesus* and *Homo* the fourth nerve only communicates,

and the plexus is formed by the fifth cervical to first dorsal inclusive.

The fourth nerve communicates with the fifth and becomes the suprascapular nerve, and the phrenic nerve arises from the junction of the fourth and communicating branches. Filaments may run from the communicating twigs from the cervical plexus to suprascapular and phrenic nerves. In *Macacus rhesus*, according to Brooks (**1**), the large fourth cervical gives a branch which joins the small fifth cervical just as the latter gives off the phrenic nerve. In *Homo* the phrenic nerve receives definite fibres from the third, fourth, and fifth cervical nerves, and the suprascapular nerve arises from the fifth and sixth cervicals.

The fifth, sixth, and seventh nerves quickly divide into anterior and posterior divisions, but the eighth does not divide. So there

Text-figure 23.
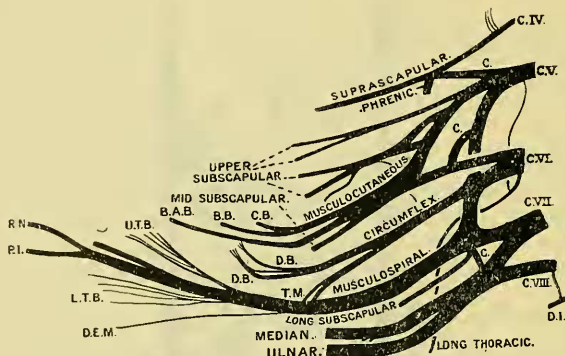
The brachial plexus. The three small fibres running up from C.iv are known in the text as C.C.P. The two small twigs attached to the median nerve are the anterior thoracics. C: communicating nerves; C.B: coraco-brachialis; B.B: biceps; B.A.B: brachialis anticus; R.N: radial nerve; P.I: posterior interosseous nerve.

is no trace of trunks as seen in *Homo*, and there is no upper trunk as in *Macacus rhesus*.

The anterior division of the fifth nerve gives off the upper and middle subscapular nerves, and unites with the anterior division of the sixth to form the musculo-cutaneous and middle subscapular nerves. In *Macacus rhesus* two small subscapulars come from the posterior division of the upper trunk (C. v and C. vi). It is possible that the musculo-cutaneous is the only representative of the outer cord of the plexus in *Homo*.

The posterior branches of the fifth and sixth nerves can be traced into the musculo-spiral and circumflex nerves, and the musculo-spiral nerve is joined by the anterior division of the seventh. In *Macacus rhesus* the posterior of the upper trunk unites with a branch of the seventh cervical nerve to form a

trunk which divides into middle subscapular and circumflex. The musculo-spiral nerve is formed by the posterior division of the conjoined fifth and sixth, the posterior division of the seventh, and the posterior division of the conjoined eighth cervical and first dorsal nerves as in *Homo*.

The posterior division of the seventh and the whole of the eighth cervical nerves fuse to form a trunk which divides into median and ulnar nerves. The median has externally only a single head of origin, so it differs from those of *Macacus rhesus* and *Homo*, in which two were seen.

Text-figure 24.
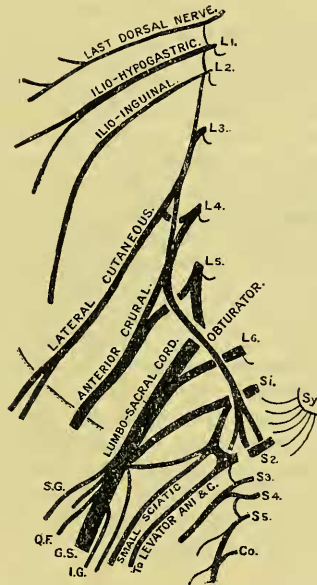
The lumbo-sacral plexus. S.G. and I.G : superior and inferior gluteal nerves ; Q.F : to quadratus femoris ; G.S : great sciatic ; Sy : sympathetic.

The *long subscapular nerve* arises from the back of the musculo-spiral nerve as in some examples of *Macacus rhesus* (**1**). And Brooks points out that, although its origin may vary considerably, it is always related in some way to the musculo-spiral.

The nerves to the pectoral muscles arise from the median nerve, but they may simply run through the latter for a considerable distance.

In my opinion the musculo-cutaneous nerve represents the outer cord in the human plexus, the posterior cord is represented by the separated circumflex and musculo-spiral nerves, and the inner cord is the band which divides into median and ulnar nerves. It is, however, difficult to explain how the median and

external anterior thoracic nerves have no connection with the outer cord.

The *musculo-cutaneous nerve* gives off branches to the coraco-brachialis, biceps, and brachialis anticus, and the latter is of considerable length.

The *circumflex nerve* gives off a large nerve to the teres minor (T.M), but no ganglion is present on it as in Man. The remainder runs round the humerus, and divides into two parts which end in the deltoid (D.B).

The *musculo-spiral nerve* gives off upper and lower branches to the triceps (U.T.B and L.T.B), and a long branch to the dorso-epitrochlearis (D.E.M). It turns sharply round the humerus, and divides into radial and posterior interosseous nerves at a point an inch proximal to the elbow joint.

The *Nerve of Bell* (long thoracic) arises from the sixth nerve, and receives a fine communicating branch from the fifth.

The *Lumbo-sacral Plexus* (text-fig. 24) is a long series of anastomoses between spinal nerves, and the branches are long and comparatively unbranched till they leave the abdomen and pelvis. The arrangements differ from those in Man, for there are more spinal nerves, and the muscles differ.

The plexus communicates above with the last dorsal nerve.

The first lumbar nerve communicates with the last dorsal and second lumbar nerves, and becomes the ilio-hypogastric nerve. The second lumbar nerve communicates with the first and third and becomes the inguinal. The second, third, and fourth enter into the lateral cutaneous nerve of the thigh. The third and fourth form the obturator nerve. The third, fourth, and fifth form the anterior crural. The fifth and sixth unite to form the lumbo-sacral cord which passes to the sacral plexus. The sacral and coccygeal nerves give mesial and lateral branches. The mesial ones include muscular nerves to levator ani, coccygeus, and pyriformis. The lateral ones include both sciatics, both gluteals, and the nerve to quadratus femoris.

Summary and Conclusions.

The following facts are described for the first time in the Primates except Man :—

1. The delto-pectoral triangle and contents.
2. The costo-coracoid ligament replaced by a costo-humeral.
3. The double nerve supply of the Axelbogen.
4. Confluence of both ejaculatory ducts.
5. Absence of the sinus pocularis.
6. The right ventricle forming the cardiac apex.
7. The Annulus of Vieussens encircling the subclavian and vertebral arteries.
8. The absence of any semilunar ganglia in the solar plexus.
9. Analysis of the lumbar plexus.
10. Absence of the mid-sacral artery.

The Drill differs from the other Old World Monkeys in the following respects :—

1. The clavicular origin of the pectoralis major is reduced to the extreme sternal end, whereas the deltoid has a longer clavicular origin than in other Primates.

2. The rhomboids do not reach the occiput.

3. The subclavius is more powerful.

4. The latissimus dorsi does not arise from any ribs.

5. The long head of the triceps has a very extensive origin from the scapula.

6. The teres major, latissimus dorsi, and dorso-epitrochlearis are fused.

7. The pancreas is extremely small.

8. The vesiculæ seminales consist of lobules.

9. The arrangement of the great veins of the face and neck.

10. The arrangement of the branches of the brachial and lumbar nerves.

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